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[Title of the Invention] GMPLS label management apparatus and GMPLS label management system

[Scope of the Invention to be Claimed]

[Claim 1]

A GPMLS (Generalized Multi-Protocol Label Switching) label management apparatus uniformly controlling a plurality of kinds of switch devices by using labels, characterized in that a function portion controlling switches is divided into resource management means for managing labels and switch control means respectively provided for a plurality of kind of switches for controlling the switches.

[Claim 2]

A GPMLS (Generalized Multi-Protocol Label Switching) label management apparatus uniformly controlling a plurality of kinds of switch devices by using labels, characterized in comprising:

switch device control means respectively provided for switch devices for implementing switching setting of the switch devices;

inter-device connection means for implementing connection control between switch devices;

label memorizing means including a plurality of label information tables registering whether labels are in use or not in use;

a port information table having entries the number of which is identical to the number of ports of the apparatus, the port information table registering the label information tables associated with the respective ports and the device control means and/or the inter-device connection means; and

resource management means for, when receiving a label setting request for performing label setting within one switch or a port-connection request for connecting ports between switches of different kinds, searching said port information tables from the port designated by this request, for detecting the label information table and device control means and/or inter-device connection control means associated with said designated port, for registering the port designated by said request as being in use in the detected label information table, and for instructing said device control means and/or inter-device connection control means to perform

setting of the switch device.

[Claim 3]

The GPMLS label management apparatus according to claim 1 or 2, characterized in that said switch devices include at least two of an optical switch, an MPLS (Multi-Protocol Label Switching) switch, a TDM switch, and a wavelength switch.

[Claim 4]

The GMPLS label management apparatus according to any one of claims 1 to 3, characterized in that said resource management means manages information related to bandwidth, and LSP (Label Switched Path) information.

[Claim 5]

A GPMLS (Generalized Multi-Protocol Label Switching) label management system provided with GMPLS label management apparatuses respectively provided for switch devices for respective kinds of the switch devices, which uniformly controls the switch devices by using labels, characterized in that each of the GMPLS label management apparatuses comprises:

switch device control means for

implementing switching setting of said switch devices;

a plurality of label information tables registering whether labels are in use or not in use;

a port information table having entries the number of which is identical to the number of ports of the apparatus, the port information table registering the label information tables associated with the respective ports and the device control means; and

resource management means for, when receiving a label setting request for performing label setting within one switch or a port-connection request for connecting ports between switches of different kinds, searching said port information tables from the port designated by this request, for detecting the label information table and device control means associated with said designated port, for registering the port designated by said request as being in use in the detected label information table, and for instructing said device control means to perform setting of the switch device,

wherein the resource management means of the plurality of GMPLS label management apparatus operates in accordance with the same algorithm.

[Claim 6]

The GPMLS label management apparatus according to claim 5, characterized in that said switch devices include at least two of an optical switch, an MPLS (Multi-Protocol Label Switching) switch, a TDM switch, and a wavelength switch.

[Claim 7]

The GMPLS label management apparatus according to claims 5 or 6, characterized in that said resource management means manages information related to bandwidth, and LSP (Label Switched Path) information.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention is related to GMPLS (Generalized Multi-Protocol Label Switching) label management apparatus and GMPLS label management system which uniformly control various devices such as optical switches, MPLS (Mutli-Protocol Label Switching) switches, and TDM switches by using labels.

[0002]

[Conventional Technique]

Recently, GMPLS (Generalized Multi-Protocol Label Switching) has been studied by standardization organizations, including IETF (Internet Engineering Task Force). The GMPLS is an extended version of MPLS in which the concept of the label path is extended to cover the wavelength and the non-packet path of SONET (Synchronous Optical Network) frames and optical fibers; the standardization is currently going on for the signaling protocol for path setting/resetting, the routing protocol for managing route information and calculating optimal paths, and the link management protocol for exchanging path information between nodes. Integrated control covering large capacity

wavelength paths and MPLS label paths can be achieved by applying the MPLS architecture which provides routing based on labels.

[0003]

A technique related to a packet transferring apparatus used for MPLS is disclosed in Patent Document 1

[0004]

[Patent Document 1]

Japanese Laid-Open Patent Application No. 2000-341294

[0005]

[Problem which the Invention Tries to Solve]

Although the GMPLS provides uniform control by using various devices, such as optical switches, MPLS switches and TDM switches, control methods within the apparatus is different depending on the devices. The sections commonly used by all the devices are desirably integrated to one unit.

[0006]

The present invention is achieved in light of the above-described circumstances; an object of the present invention is to provide a GMPLS label management apparatus and a GMPLS label management system in which a resource management unit which manages labels is separated from a

switch control unit which controls devices, and controls of respective devices are achieved by searching a related port information table and the like in label information operation and identifying the switch control unit which actually provides the device operation.

[0007]

[Means to Solve a Problem]

In order to achieve the above-described object, the invention as set forth in Claim 1 is a GMPLS (Generalized Multi-Protocol Label Switching) label management apparatus uniformly controlling a plurality of kinds of switch devices by using labels, characterized in that a function unit control the switches is divided into a resource management unit which manages labels and switch control units respectively provided for the plurality of kinds of switches to control the switches.

[0008]

The invention as set forth in Claim 2 is a GPMLS (Generalized Multi-Protocol Label Switching) label management apparatus uniformly controlling a plurality of kinds of switch devices by using labels, characterized in comprising: switch device control means respectively provided for switch devices for

implementing switching setting of the switch devices; inter-device connection means for implementing connection control between switch devices; label memorizing means including a plurality of label information tables registering whether labels are in use or not in use; a port information table having entries the number of which is identical to the number of ports of the apparatus, the port information table registering the label information tables associated with the respective ports and the device control means and/or the inter-device connection means; and resource management means for, when receiving a label setting request for performing label setting within one switch or a port-connection request for connecting ports between switches of different kinds, searching the port information tables from the port designated by this request, for detecting the label information table and device control means and/or inter-device connection control means associated with the designated port, for registering the port designated by the request as being in use in the detected label information table, and for instructing the device control means and/or inter-device connection control means to perform setting of the switch device.

[0009]

The invention as set forth in Claim 3 is in accordance with Claim 1 or 2, characterized in that the switch devices include at least two of an optical switch, an MPLS (Multi-Protocol Label Switching) switch, a TDM switch, and a wavelength switch.

[0010]

The invention as set forth in Claim 4 is in accordance with any one of Claims 1 to 3, characterized in that the resource management means manages information related to bandwidth, and LSP (Label Switched Path) information.

[0011]

The invention as set forth in Claim 5 is a GPMLS (Generalized Multi-Protocol Label Switching) label management system provided with GMPLS label management apparatuses respectively provided for switch devices for respective kinds of the switch devices, which uniformly controls the switch devices by using labels, characterized in that each of the GMPLS label management apparatuses comprises: switch device control means for implementing switching setting of the switch devices; a plurality of label information tables registering whether labels are in use or not in use; a port information table having

entries the number of which is identical to the number of ports of the apparatus, the port information table registering the label information tables associated with the respective ports and the device control means; and resource management means for, when receiving a label setting request for performing label setting within one switch or a port-connection request for connecting ports between switches of different kinds, searching the port information tables from the port designated by this request, for detecting the label information table and device control means associated with the designated port, for registering the port designated by the request as being in use in the detected label information table, and for instructing the device control means to perform setting of the switch device, wherein the resource management means of the plurality of GMPLS label management apparatus operates in accordance with the same algorithm.

[0012]

The invention as set forth in Claim 6 is in accordance with Claim 5, characterized in that said switch devices include at least two of an optical switch, an MPLS (Multi-Protocol Label Switching) switch, a TDM switch, and a wavelength

switch.

[0013]

The invention as set forth in Claim 7 is in accordance with Claims 5 or 6, characterized in managing information related to bandwidth, and LSP (Label Switched Path) information.

[Embodiments of the Invention]

[0014]

Next, a detailed description will be given of embodiments of the GMPLS label management apparatus and the GMPLS label management system according to the present invention, with reference to the attached drawings. Referring to FIGs. 1 to 6, the GMPLS label management apparatus and the GMPLS label management system according to the present invention are illustrated.

[0015]

First, a description is given of the configuration of a first embodiment with reference to FIG. 1. As shown in FIG. 1, the present embodiment is provided with a resource manager 101, a port information table 102, a label database 103, a label database 103, an MPLS switch controller 104, an optical switch controller 105, an MPLS switch unit 106, optical

transmitters 107 and 108, optical receivers 109 and 110, an optical switch unit 111, a protocol controller 112, and a command controller 113.

[0016]

A resource manager 101 manages label information, port information, and the like by using a port information table 102 and a label database 103.

[0017]

The port information table 102 has entries the number of which is identical to the number of ports provided for the apparatus. The label database 103 has a plurality of label information tables, and further, each table has a plurality of entries. The resource manager 101 receives a label setting request and a port connection request from the protocol controller 112 and the command controller 113. In accordance with the commands, the resource manager 101 issues device setting requests to the MPLS switch controller 104, the optical switch controller 105, and the port connection controller 114 between the optical switch and the MPLS switch.

[0018]

The MPLS switch controller 104 provides the setting of the MPLS switch 106, and the optical switch controller 105 and the port connection

controller 114 between the optical switch and the MPLS switch provides the setting of the optical switch unit 111. The MPLS switch unit 106 has four ports, referred to as Ports 9 to 12, and forwards MPLS packets received from optical receivers 109 and 110 in accordance with the setting from the MPLS switch controller 104 to output the MPLS packets to optical transmitters 107 and 108. The optical switch unit 111 has eight ports, referred to as Ports 1 to 8, providing switching of optical signals from the optical transmitters 107 and 108 and external optical signals, in accordance with the setting from the optical switch controller 105 to optically output the optical signals to the optical receivers 109 and 110 or an external device.

[0019]

The protocol controller 112 performs inter-node communications, and when the counterpart node issues a path setting request, the protocol controller 112 issues a label request to the resource manager 101 in response to the path setting request. The command controller 113 receives and analyses commands transmitted through the telnet and commands input from a control console and the like, and issues a label

setting request to the resource manager 101 in response to the analysis result.

[0020]

The present embodiment structured as described above is characterized in that the resource manager which manages labels is separated from the switch controllers which control devices, and controls of respective devices are achieved by searching a related port information table in label information operation and identifying the switch controller which actually provides the device operation. The present embodiment is also characterized in that the addition of a new device to the apparatus only requires to add a switch controller and to modify the port information table, due to the fact that the position of the switch controllers are stored in the port information table; there is no need to modify resource management.

[0021]

A description is given of the operation procedure of the present embodiment with reference to FIG. 1.

First, a description is given of the operation in carrying out the label setting within one switch.

For carrying out the label setting within

one switch, the protocol controller 112 or the command controller 113 issues a label setting request to the resource manager 101. To the resource manager 101, an input label, an output label, an input port, and an output port are forwarded as parameters.

[0022]

Upon receiving the label setting request, the resource manager 101 searches the port information table for the identified input port and output port. Entries of the port information table 102 is as shown in Fig. 2, and the position of the label information table associated with these ports and the position of the switch controller to be used are obtained from the entries. As shown in Fig. 3, each entry of the label information table includes the value of a label and the state denoting whether the label is in use. The resource manager first searches the obtained label information table for the input label, and records "In Use" in the searched entry. If necessary, similar processing is carried out for the output label.

[0023]

Next, the switch controller associated with the port is called by using the obtained position of the switch controller to instruct the switch

connection. The entries of the port information table preliminary contains: the position of the MPLS switch controller for the case where the corresponding port is a port of the MPLS switch, or the position of the optical switch controller for the case where the corresponding port is a port of the optical switch, and appropriate one of the MPLS switch controller and the optical switch controller is successfully called by calling the switch controller in accordance with the entries. Also, the switch controller is successfully called without requiring the calling side to adapt the kind of the switch, by providing each of the switch controllers with the same calling interface. The MPLS switch controller 104 carries out the setting of the MPLS switch unit 106 in accordance with the switch connection request given from the resource manager 101. From this setting on, switching is carried out when a packet with an appropriate label is input into the MPLS switch. Also, the optical switch controller 105 carries out the setting of the optical switch unit 111 in accordance with the switch connection request given from the resource manager 101. Switching is carried out by this setting when an optical signal is input into an appropriate port.

[0024]

The flow of the above-described label setting processing will be described with a specific example with reference to the flowchart shown in Fig. 4.

Consider the case when the received label setting request includes an input port "4", an input label "100", an output port "2", and an output label"200" (Step S1). The resource manager 101 searches the port information table with the input port "4" used as a key (Step S2). If the port information table is assumed to be as shown in Fig. 2, the label information table "1" is obtained as the label information table, and the position of the optical switch controller is obtained as the switch controller position. With respect to the obtained label information table "1", the input label "100" is marked as "In Use" (Step S3). Correspondingly, the label information table is obtained for the output port, and the output label "200" is marked as "In Use." Next, a switch controller is called by using the input port, the input label, the output port, and the output label as parameters (Step S4). Since the position of the optical switch controller 105 is obtained, the optical switch controller 105 is called. The optical switch controller 105

implements the setting of the optical switch unit 105 in accordance with the given parameters (Step S6).

[0025]

Next, a procedure for providing an inter-switch port connection between the MPLS switch and the optical switch.

The protocol controller 112 or the command controller 113 issues a port connection request to the resource manager 101. Three parameters including an input label, an input port, and a connection destination port, or three parameters including an output label, an output port, and a connection destination port are transferred to the resource manager 101 as parameters.

[0026]

Upon receiving the port connection request, the resource manager 101 searches the port information table for the designated input port or output port. Entries of the port information table are as shown in Fig. 2, and from the entries, the position of the label information table associated with these ports is obtained. The resource manager 101 searches the obtained label information table for the input label or the output label, and records "In Use" in the searched entry.

[0027]

Next, the port information table is searched for the designated connection destination port to obtain the position of the connection controller between the switches. With the use of the position of the connection controller between the switches, the connection controller between the switches associated with the port is called to instruct the connection between the switches. Each entry of the port information table preliminarily contains the position of the connection controller 114 between the optical switch and the MPLS switch. The connection controller 114 between the optical switch and the MPLS switch controls the optical switch unit by using the designated label and port value to establish a connection between the switches.

[0028]

The flow of the above-described connection processing between the switches will be described with a specific example with reference to Fig. 5. Consider the case that the received port connection request includes the output port "2", the output label "200", and a connection destination port "9" (Step S10). The resource manager 101 searches the port information table

with the connection destination port "9" used as a key (Step S11). If the port information table is assumed to be as shown in Fig. 2, the label information table "2" is obtained as the label information table, and the position of the port connection controller between the optical switch and the MPLS switch is obtained as the port connection controller position. The output label "200" of the obtained label information table is marked as "In Use" (Step S12). Next, a port connection controller is called by using the output port, the output label, and the port connection controller as connection destination port parameters (Step S13). As a result, the port connection controller 114 between the optical switch and the MPLS switch is called, and the optical switch unit 111 is set in accordance with the given parameters (Step S14).

[0029]

As thus described, the present embodiment divides the portion to control switching upon reception of a label setting request into a switch-dependent controller and a common portion that is not switch-dependent, and thereby reduces the necessary amount of the memory in the apparatus provided with various kinds of switches. Also, when a different kind of switch is newly

added to the apparatus, it only requires to add a switch-dependent controller; there is no need for modifying the common portion. Additionally, when the switch control method is modified, it only requires modifying the switch-dependent controller.

[0030]

Although the optical switch and the MPLS switch are exemplified in this embodiment, TDM switches, wavelength switches and the like may be used, and also, any combinations of optical switches, MPLS switches, TDM switches and wavelength switches may be used. Also, although the case of only two kinds of switches is described, a combination of three or more kinds of switches may be used. Although the resource manager 101 manages only the label use state in this embodiment example, the resource manager 101 may manage associated information such as bandwidth information and LSP (Label Switched Path) information.

[0031]

A description will be given of a second embodiment of the present invention with reference to the attached drawings. The structure of this embodiment is shown in Fig. 6. This embodiment is directed to two apparatuses having

different switches, and is different from the first embodiment in that one apparatus controls one kind of switch.

[0032]

Since there is one kind of switch unit, one kind of label information table and switch controller are provided, and the port information table stores one label information table position and one switch controller position. Therefore, one switch controller that corresponds to the switch is called in the label setting.

[0033]

In this embodiment example, common managers (the control algorithm of which is same) can be used as resource managers 503 and 510 of the two apparatuses to reduce the cost. Also, the size reduction of the controller is achieved by preparing only a switch controller that corresponds to the kind of the switch portion.

[0034]

It should be noted that the above-described embodiments are preferred embodiments of the present invention. The invention is not limited to these embodiment, and may be implemented as various modifications in the scope which is not out of the basic concept of the present invention.

[0035]

[Advantage of the Invention]

As is apparent from the above description, the present embodiment divides the portion to control switching upon reception of a label setting request into a switch-dependent controller and a common portion that is not switch-dependent, and thereby reduces the necessary memory amount of this portion in the apparatus provided with various kinds of switches.

[0036]

Also, when a different kind of switch is newly added to the apparatus, it only requires to add a switch-dependent controller; there is no need for modifying the common portion. Additionally, when the switch control method is modified, it only requires modifying the switch-dependent controller.

[Brief Description of the Drawings]

[FIG.1]

FIG. 1 is a block diagram showing the configuration of the first embodiment of the present invention.

[FIG.2]

FIG. 2 is a diagram showing the structure of the port information table.

[FIG.3]

FIG. 3 is a diagram showing the structure of the label information table.

[FIG.4]

FIG. 4 is a flowchart showing the procedure for implementing label setting within one switch.

[FIG. 5]

FIG. 5 is a flowchart showing the procedure for providing a connection between two switches.

[FIG. 6]

FIG. 6 is a block diagram showing the configuration of the second embodiment of the present invention.

[Description of the Reference Numerals]

101 Resource manager
102 port information table
103 label database
104 MPLS switch controller
105 optical switch controller
106 MPLS switch unit
107, 108 optical transmitter
109, 110 optical receiver
111 optical switch unit
112 protocol controller
113 command controller